

CONVERTER FROM MOODLE LESSONS TO INTERACTIVE EPUB EBOOKS

¹Martin Takev, ¹Elena Somova, ²Miguel Rodríguez-Artacho

¹University "Paisii Hilendarski" – Plovdiv (Bulgaria)

²UNED University – Madrid (Spain)

Abstract. This article describes a software, that automatically converts already created Moodle Learning Resources of type "lessons" into interactive e-books, stored in EPUB format. The advantages of EPUB format to present learning content are discussed, as well as existing examples of its use in education. Emphasis is given to creating interactive EPUB lessons that enable tracking learners' activities and saving their current progress with the help of xAPI statements and stateAPI implementation.

Keywords: EPUB; xAPI; e-learning environment; educational content modelling; educational authoring; Learning Analytics

1. Introduction

Modern learners are not the ones for whom the traditional education system was created. Students have other requirements and expectations from their education. They use various technologies, widely available to everybody. The use of mobile devices, smartphones, fablets and tablets is fully integrated into people's natural life and social activities (Gaftandzhieva, Kasakliev & Doneva, 2016).

On one hand, learners have to interact with multiple learning objects (to view learning resources in the form of texts and video lectures, to complete assignments, take tests, experiment with physical or virtual objects, participate in discussions, etc.) and in most cases this requires them to switch to different learning environments (web browsers, video players, textbooks, physical or virtual laboratories, etc.). In recent years it has been worked considerably for **the integration of these learning environments**. There are many **e-learning environments** that offer an integrated set of services and resources for the different types of participators in the learning process (student, lecturer, author and administrator). Two of the most fundamental drawbacks of these e-learning environments are the relative complexity of the interface, due to the many opportunities, and the need for constant Internet access during learning.

On the other hand, the e-book market is currently in a strong upsurge. **E-books** offer easy access to educational content and learning activities using well-known

mobile devices, without the need of constant Internet connection. The use of **mobile devices** fully transfers **education anywhere and at any time**.

The main goal of the article is to present a converter of existing Moodle lessons to interactive EPUB e-books.

Section 2 examines the advantages of the EPUB e-book format when it is used for educational content, and its structure is given in Section 3. Actual examples of EPUB use in education are shown in Section 4. Section 5 presents the authors' Moodle lessons converter. The article ends with a conclusion, summarizing the authors' work and some perspectives for development.

2. EPUB Advantages

The EPUB¹⁾ format is a standardized open e-book format that can be downloaded and read on different devices like smartphones, tablets, PCs or e-book readers. EPUB is the most widely supported vendor-independent XML-based e-book format and therefore it's easily used.

EPUB introduces mechanisms to provide interactivity and multimedia integration using JavaScript and HTML5. In this way, EPUB can track learner's activities in web-based learning environments.

(Chang & Hung, 2018) compares two content models – EPUB for e-books and SCORM for e-learning, in terms of their content presentation, metadata and packet structure. The authors identify the main **advantages of EPUB**:

- Content is easily shared and reused;
- Integration of multimedia and interactive components based on web technologies (despite limited media types);
- no special metadata related to the education;
- mechanism for automatic adjustment and content reformat for devices with small screen sizes;
- All resources can be used offline.

Tse (2013) shows as **an advantage of using EPUB format** for presenting learning content – **the simplicity of downloading** content, which puts the consumption of learning materials directly into the hands of the individual learner. According to Tse, the creation of educational content that captures and maintains learners' focus is a great challenge.

Another **advantage of the format** is emphasized in (Murphy, Martin, & Farley, 2012) – providing access to an educational course's electronic content **without** learners having permanent **Internet access**. (Murphy, Martin, & Farley, 2012) presents a pilot study on the use of e-readers in higher education by looking at the steps taken, as well as at the challenges and obstacles that have arisen from the EPUB conversion.

(Gailer, et al., 2014) focuses on the **openness** of EPUB, which promotes open learning and teaching in a meaningful way.

3. EPUB Structure

The EPUB format is a compressed ZIP file containing a package of files. There are the required structure and metadata files, located in the META-INF directory, and a mimetype file showing the actual file type to e-readers²⁾.

Main component is the manifest file that structures and references the rest of the elements. EPUB content is structured by the OPF file, which determines the index, and the HTML files that describe the book content and formatting (using CSS files).

EPUBs can be downloaded and read on different devices, because all modern devices have an e-book reading software. Thus, the EPUB resources can be used by students or teachers both off-line and on-line with the user's favourite contemporary device and reading software.

4. Examples of Using EPUB

The research of (Gailer, et al., 2014) notes that EPUB is suitable for different types of exercises and is able to serve as the main format for upcoming digital textbooks. Gailer, et al. (2014) is developing a didactic and technical concept for implementing various exercises in an e-book. Such e-book prototype is created, consisting of a **set of interactive exercises**.

The authors of Sigarchian, et al. (2015) created e-Textbook – a prototype of a mobile learning environment, based on EPUB. In it they have integrated three interactive widgets that can interchange information and create semi-automatic new content: a report maker widget, a sine formula widget and a corresponding interactive graph maker widget. Objects, offering contextual content, and various sets of learning objects have been incorporated into the environment (including multimedia objects, **objects with augmented reality features**, i.e. digital objects that allow interaction with physical objects). E-TextBook also provides a unified mobile learning environment through interoperable packed semantically annotated learning content.

Lohr (2014) presents the attempt of an Austrian school to offer **blended learning** using personal computers and iPads. Science education is done **through e-books in pdf, epub and ibook** format. They report that the ibook format, although better in integrating interactive elements, use of dictionaries and tagging tools, has a major drawback – it is only available for iPads, unlike the open pdf and epub formats. Seamlessly creating e-books with the software pages available for Mac OS and iOS is suited to the epub format, but the production of interactive ibooks can be done only with the available only for Mac OS iBooks Author software.

Although the undisputed advantages of gamification in learning, the gamified e-books and systems are few. The authors in (Heyvaert, Verborgh, Mannens, & Van De Walle, 2015) create the GEL (Gamification for EPUB, using Linked Data) framework, which allows embedding **gamification concepts in a digital textbook** using EPUB and Linked Data. They have created the ontology Gamification

Ontology (GO), which presents the various concepts of gaming, and allows the discovery of other gamified e-books.

Figueiredo, Bidarra & Bostad (2016) show tools for expanding the classroom into a blended learning model, where **e-books** in EPUB standard incorporating lecture and problem-solving videos, **teach mathematics** to students in secondary education in a more comprehensive manner.

E-books in HTML and EPUB formats are **more accessible** than PDF books. This statement is proved by researchers at (Sun, et al., 2018), who are **studying the availability** of 140 publicly accessible electronic textbooks from the California Open Online Library for Education (COOL4ed). Each textbook is evaluated for compliance with 15 control points/accessibility points developed by the MERLOT (Multimedia Educational Resource for Learning and Online Teaching) project through an assessment system, specifically created for electronic textbooks. Furthermore, each textbook is evaluated in more than one format (EPUB, HTML or PDF).

Uosaki, Kiyota, Mouri, Ogata, & Choyekh (2016) present **the use of EPUB in ubiquitous learning**, which is applied to the Japanese language learning system SCROLL (System for Capturing and Reminding of Learning Log). They improve their system by adding EPUB functionality to increase the efficiency and enrich the content of their tests. The pilot assessment conducted shows sufficient results, despite the negative attitude shown by some learners.

5. Creating Lessons in EPUB Format

5.1. Moodle Lesson

One of the most usable and useful activities in the e-learning environment Moodle is the “**lesson**”³⁾. It is composed of a series of HTML pages, consisting of learning content and a list of actions, each leading to one of the other pages of the lesson. Sometimes this navigation, created by the authors can be very complex, but it is the base that forms the adaptive nature of the lesson module and with correct planning and customization, each individual student’s learning path may differ.

There are two basic lesson page types: **content pages** and **question pages**. Question pages provide the option to place so-called in-text questions (ITQs), which evaluate the learning materials just passed and studied from the previous pages. Which in turn leads to different page navigation for the specific levels of knowledge, displayed by the learners and the lesson can be designed to be adaptive and use student’s choices to generate a self-directed lesson.

In the Moodle lesson module **6 types of questions** are available⁴⁾: Multichoice (or Multiple answer), Essay, Matching, Numerical, Short answer (incl. fill in the blank) and True/false.

5.2. Convert Moodle lesson to EPUB format

When converting a Moodle lesson to EPUB format, **the same behaviour** from the e-learning environment must be recreated into the EPUB document. This is

done by generating an interactive EPUB file with JavaScript, delivering exactly identical learning process –visualization of lesson pages, page navigation, questions and their answers.

The main focus of the work is **tracking learners' actions** throughout their use of EPUB lessons. The EPUB lesson files are located outside of the e-learning environment, which leads to the need of additional actions to track the activities, performed by learners – opening a lesson, reading a lesson or a page of a lesson, completing a lesson or answering lesson questions. This is achieved by using the xAPI specification⁵⁾, JavaScript codes and the xAPIWrapper⁶⁾ that carry out the communication between the EPUB file and the LRS (Learning record store).

The specification Experience API (or xAPI)⁵⁾ is described as a next generation e-learning standard, which combined with SCORM allows e-learning to use modern technologies in an interoperable way. A traditionally passive e-books are turned into interactive educational platforms, tracking learner activities by means of the Learning Record Store (LRS), that holds the structured interactions in a cloud-based model.

EPUB allows the use of JavaScript embedded code to describe user actions, following the guidelines of composing **xAPI statements**. The xAPI collects data about the wide range of experiences a person has done online or offline in statements in the form of “Noun, verb, object” (e.g. “I did this”). User activities are saved as statements in LRS. The LRS can exist on its own, or inside an LMS and it can share these statements with other LRSs.

When learners perform certain actions on the lesson, xAPI phrases are generated and sent to the LRS. From the student activity data recorded, different reports can then be made only for statistical purposes or as well for adapting the overall learning process.

Another key moment of the work is the ability to **save users' current progress or state (the stateAPI⁷⁾**, i.e. where the student stands in terms of completing the learning material. EPUB lessons can be downloaded and opened by different devices. The lack of a single system to access the learning content (as is the case in Moodle) raises the problem of tracking how far a user has gone through the lesson and when the user is opening the same lesson on another device – continuing the studying from the exact position, reached on the previous device. This is accomplished with the xAPI specification and its stateAPI, that uses stored information in the LRS to detect what content a user has already read and what still has to be completed. The LRS needs to keep parameters⁸⁾ like: the user (also references as an agent), who is reading the EPUB file, the ID of the activity, that this user is currently working on, the value, that needs to be saved as a state and optionally a unique identifier (time-stamp) for this state.

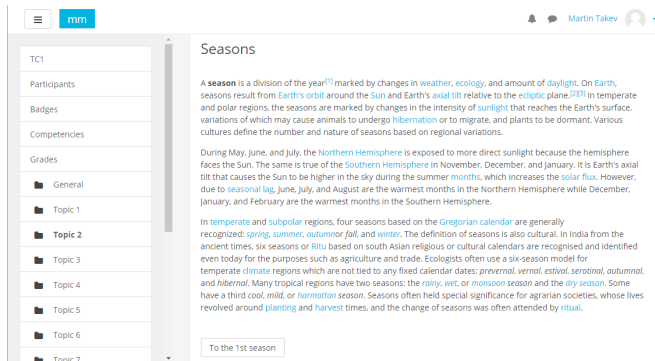


Figure 1-a. Lesson content page preview in Moodle

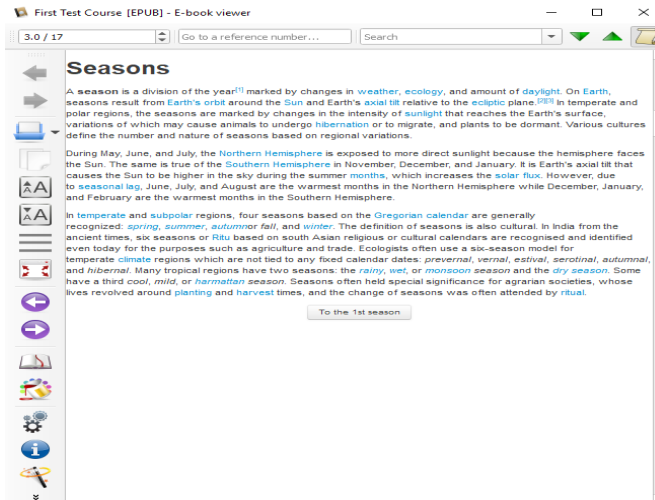


Figure 1-b. Lesson content page preview in EPUB

For example, when reaching the 5th page of a lesson, a request is sent to the endpoint for the LRS (e.g. <http://example.com/xAPI/activities/state>) where this information is saved and the next time when the EPUB lesson is opened by the same user, even if this is done from another device – the lesson is opened right after the 5th page, so the learner can continue right where he had left.

5.3. Example EPUB lesson

The section provides an example lesson, containing both content and question pages, that is exported to an EPUB format file. In the EPUB lesson, the content is displayed to

the learners one page at a time, similar to how the lesson is perceived in the e-learning environment. The rest of the pages are visualized after specific user actions have been undertaken – navigating to the appropriate part of the lesson or answering to a question.

As Moodle is an online learning environment and it uses HTML for visualization, after converting to EPUB format, there are hardly any differences in the displayed lesson (see Figure 1 and Figure 2). Figure 1 illustrates the preview of a content page in Moodle and in EPUB format, and Figure 2 – of a multichoice question page.

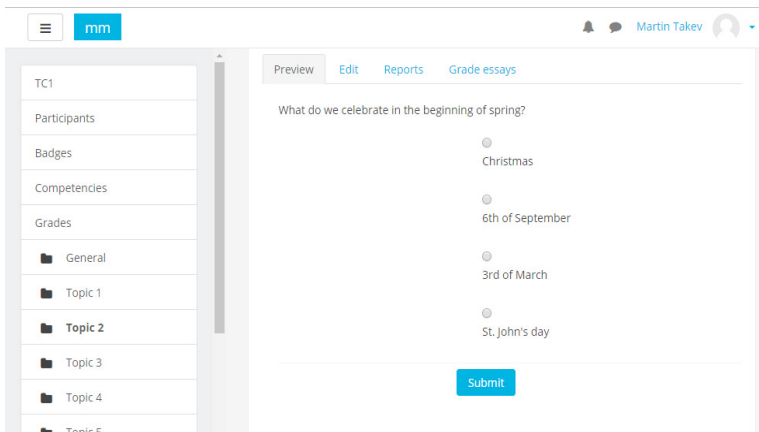


Figure 2-a. Lesson question page preview in Moodle

JavaScript code is used **to check the learner's answers** to the question pages and, depending on the correctness of the answer, it is decided on which page to redirect the learner (analogous to the behaviour of Moodle).

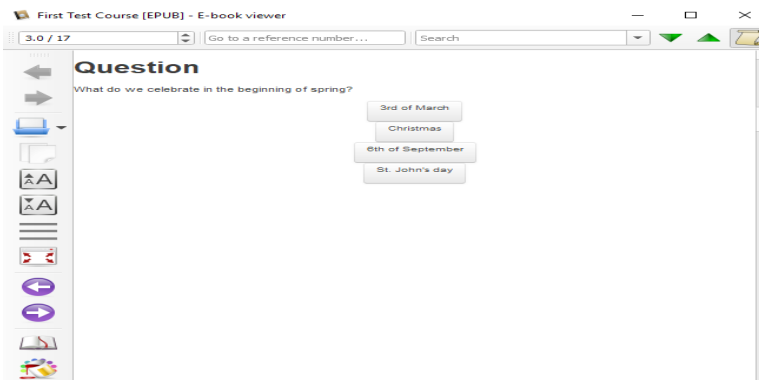


Figure 2-b. Lesson question page preview in EPUB

When an **EPUB file is opened**, it is checked whether the user has already opened the lesson **on another device**. If yes, then the StateAPI takes the value that has been recorded as a session (which page of the lesson has the learner reached earlier) and opens the corresponding page to continue the lesson from where it was previously finished at the last opening of the file. If no session is found, the lesson opens from the first page.

To accomplish the tracking of the students and their activity onto the EPUB lesson, the following events can be specified: opening the lesson, going to a lesson page, answering a question and completing the lesson. For every event, requests are sent to the LRS with information about who, what and when they did in the lesson in the form of xAPI statements.

6. Conclusion

E-books provide easy access to learning content and activities without the need of constant internet access and using the well-known to users' mobile devices. This article presented a Moodle plugin, capable of converting lesson modules to interactive EPUB e-books. It also highlighted the advantages of having learning materials in EPUB format and existing examples of its application in education. The creation of interactive EPUB lessons, tracking learners' actions by sending xAPI statements to an LRS and saving their progress throughout different devices with session states (state API), is fully covered.

The developed software tool will be integrated with the mobile application – Mobile LAP (Gaftandzhieva, Doneva, Petrov & Totkov, 2018) that allows students to track their activity and success rate during training and compare them with the average level of activity and success rate of the other students, in order to increase their success, as well as to track whether they adhere to the learning schedule.

The software would be further extended to convert other Moodle modules and to increase the range of generated statements, making the tracking of more student activities possible. Implementing the EPUB e-books in education could help in achieving greater accessibility of the learning material and encourage spending more time on it. All of this contributes to the possibility of making vast reviews on students' behavior, which can be then analyzed to fully understand user's participation in the learning process.

NOTES

1. International Digital Publishing Forum (IDPF). EPUB 3.0.1. <http://idpf.org/epub/301>. Accessed 05.05.2019
2. edrLAB. <https://www.edrlab.org/epub/anatomy-of-an-epub-3-file>. Accessed 05.05.2019
3. Lesson Activity. https://docs.moodle.org/36/en/Lesson_activity. Accessed 05.05.2019

4. Building Lesson. https://docs.moodle.org/36/en/Building_Lesson. Accessed 05.05.2019
5. The Advanced Distributed Learning Initiative (ADL). Research & Development Experience xAPI. <https://adlnet.gov/experience-api>. Accessed 05.05.2019
6. xAPI Wrapper. <https://github.com/adlnet/xAPIWrapper>. Accessed 05.05.2019
7. Statement API. <https://www.ht2labs.com/xapi-state-api/>. Accessed 05.05.2019
8. xAPI Specification. <https://github.com/adlnet/xAPI-Spec/blob/master/xAPI-Communication.md#partthree>. Accessed 05.05.2019

REFERENCES

- Chang, H.-P. A. & Hung, J. C. (2018). Comparison of the features of EPUB e-book and SCORM e-learning content model. *International Journal of Distance Education Technologies*, 16 (2), 1 – 17.
- Figueiredo, M., Bidarra, J. & Bostad, R. (2016). The development of an ebook for teaching and learning mathematics, Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics). *10th International Conference on Universal Access in Human-Computer Interaction – UAHCI'2016*, 9739, pp. 49 – 56. Toronto, Canada.
- Gaftandzhieva, S., Doneva, R., Petrov, S. & Totkov, G. (2018). Mobile Learning Analytics Application: Using Students' Big Data to Improve Student Success. *International Journal on Information Technologies & Security*, 3 (10), 53 – 64. doi:1313 – 8251
- Gaftandzhieva, S., Kasakliev, N. & Doneva, R. (2016). Mobile Application for Quality Evaluation of Learning. *QED'16: Technology Advanced Quality Learning for ALL*, (pp. 32 – 49). Sofia, Bulgaria. doi:978-619-185-261-1
- Gailer, C. A., Ebner, M. A., Kopp, M. B., Lackner, E. B., Raunig, M. B. & Scerbakov, A. A. (2014). Potential of EPUB3 for digital textbooks in higher education, Lecture Notes in Computer Science. *European Conference on Technology Enhanced Learning, EC-TEL 2014*, 8719, pp. 564 – 5659. Graz, Austria.
- Heyvaert, P., Verborgh, R., Mannens, E. & Van De Walle, R. (2015). Linked data-enabled gamification in EPUB 3 for educational digital textbooks, Lecture Notes in Computer Science. *10th European Conference on Technology Enhanced Learning, EC-TEL 2015*, 9307, pp. 587 – 591. Toledo, Spain.
- Lohr, M. (2014). Ebooks as pdf files, in epub format or as interactive ebooks? Digital books in physics lessons of secondary education. *Proceedings of the 10th International Conference on Mobile Learning – ML 2014*, (pp. 11 – 18). Madrid, Spain.

- Murphy, A., Martin, N. & Farley, H. (2012). Using e-readers to increase access to course content for students without internet access. *ASCILITE 2012 – Annual conference of the Australian Society for Computers in Tertiary Education*, (pp. 25 – 28). Wellington, New Zealand.
- Sigarchian, H. G., De Meester, B., De Nies, T., Verborgh, R., Salliau, F., De Neve, W. & Van De Walle, R. (2015). Towards making EPUB 3-based e-TextBooks a first-class mobile learning environment. *10th International Conference on e-Learning – ICEL 2015*, (pp. 270 – 278). Bahamas.
- Sun, Y., Fritz, R. M., Yorba, L., Manabat, A. K., Katz, N. A. & Vu, K.-P. L. (2018). E-book accessibility evaluations. In *Advances in Intelligent Systems and Computing* (Vol. 596, pp. 328 – 336).
- Tse, E. (2013, December). Special issue on child computer interaction. *Personal and Ubiquitous Computing*, 17 (8), 1573 – 1575.
- Uosaki, N., Kiyota, M., Mouri, K., Ogata, H. & Choyekh, M. (2016). Onomatopoeia learning support for Japanese language learners using ubiquitous learning log system with eBook. *Proceedings – IEEE 16th International Conference on Advanced Learning Technologies, ICALT 2016*, (pp. 347 – 348). Austin, United States.

✉ **Mr. Martin Takev, PhD student**
Ms. Elena Somova, Assoc. Prof.

Computer Science Department
University of Plovdiv “Paisii Hilendarski”
24, Tzar Assen St.
4000 Plovdiv, Bulgaria
E-mail: takevm@gmail.com
E-mail: eledel@uni-plovdiv.bg

✉ **Prof. Miguel Rodríguez-Artacho**

Languages and Systems Department
UNED University
14, Calle de Juan del Rosal
28040 Madrid, Spain
E-mail: miguel@lsi.uned.es